

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau

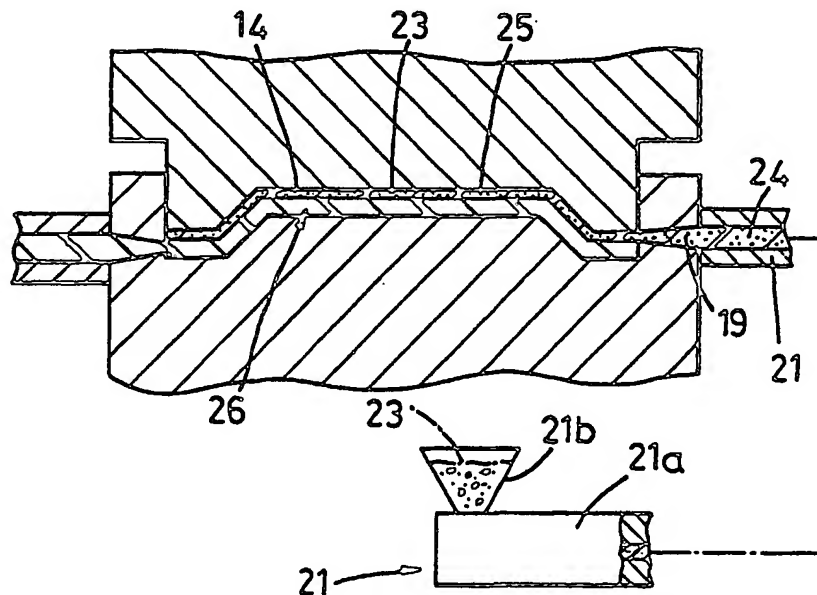
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

|   |  |   |
|---|--|---|
| (51) International Patent Classification <sup>6</sup> :<br>B29C 37/00, 45/00, 45/16   | A1   | (11) International Publication Number: WO 95/13177<br>(43) International Publication Date: 18 May 1995 (18.05.95) |
| <p>(21) International Application Number: PCT/GB94/02464</p> <p>(22) International Filing Date: 9 November 1994 (09.11.94)</p> <p>(30) Priority Data:<br/>9323339.3 11 November 1993 (11.11.93) GB</p> <p>(71) Applicant (for all designated States except US): ROVER GROUP LIMITED [GB/GB]; International House, Bickenhill Lane, Bickenhill, Birmingham B37 7HQ (GB).</p> <p>(72) Inventors; and<br/>(75) Inventors/Applicants (for US only): EASTERLOW, Ronald, Arthur [GB/GB]; 312 Broad Lane, Coventry CV5 7AT (GB). SMITH, Gordon, Frederick [GB/GB]; 31 Myton Crescent, Warwick CV34 6QA (GB).</p> <p>(74) Agents: FARROW, Robert, Michael et al.; Rover Group Limited, Patent Dept., Gaydon Test Centre, Banbury Road, Lighthorne, Warwick CV35 0RG (GB).</p> | <p>(81) Designated States: GB, JP, KR, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</p> <p>Published<br/>With international search report.<br/>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</p> |   |

(54) Title: A METHOD OF MOULDING AND A MOULDING FORMED BY SUCH A METHOD

## (57) Abstract

The method includes providing a mould (10) having at least two parts (11, 12), providing in the mould a part (22) to be coated with paint and injecting between the part (22) and an adjacent surface (14) of the mould a material (24) formed from a plastics paint. The method may include the step of opening the mould (10) slightly or allowing the mould to open slightly to define a gap (23) between the part (22) and the adjacent surface (14) of the mould, the paint then being injected into the gap to coat the part. The paint is injected by a machine (21) which receives granules of the paint for melting into an injectable form. A moulding made by such a method can take the form of a motor vehicle component which is coated with paint in the mould instead of requiring the usual step of painting by dipping or spraying.



**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

|    |                          |    |                                       |    |                          |
|----|--------------------------|----|---------------------------------------|----|--------------------------|
| AT | Austria                  | GB | United Kingdom                        | MR | Mauritania               |
| AU | Australia                | GE | Georgia                               | MW | Malawi                   |
| BB | Barbados                 | GN | Guinea                                | NE | Niger                    |
| BE | Belgium                  | GR | Greece                                | NL | Netherlands              |
| BF | Burkina Faso             | HU | Hungary                               | NO | Norway                   |
| BG | Bulgaria                 | IE | Ireland                               | NZ | New Zealand              |
| BJ | Benin                    | IT | Italy                                 | PL | Poland                   |
| BR | Brazil                   | JP | Japan                                 | PT | Portugal                 |
| BY | Belarus                  | KE | Kenya                                 | RO | Romania                  |
| CA | Canada                   | KG | Kyrgyzstan                            | RU | Russian Federation       |
| CF | Central African Republic | KP | Democratic People's Republic of Korea | SD | Sudan                    |
| CG | Congo                    | KR | Republic of Korea                     | SE | Sweden                   |
| CH | Switzerland              | KZ | Kazakhstan                            | SI | Slovenia                 |
| CI | Côte d'Ivoire            | LI | Liechtenstein                         | SK | Slovakia                 |
| CM | Cameroon                 | LK | Sri Lanka                             | SN | Senegal                  |
| CN | China                    | LU | Luxembourg                            | TD | Chad                     |
| CS | Czechoslovakia           | LV | Latvia                                | TG | Togo                     |
| CZ | Czech Republic           | MC | Monaco                                | TJ | Tajikistan               |
| DE | Germany                  | MD | Republic of Moldova                   | TT | Trinidad and Tobago      |
| DK | Denmark                  | MG | Madagascar                            | UA | Ukraine                  |
| ES | Spain                    | ML | Mali                                  | US | United States of America |
| FI | Finland                  | MN | Mongolia                              | UZ | Uzbekistan               |
| FR | France                   |    |                                       | VN | Viet Nam                 |
| GA | Gabon                    |    |                                       |    |                          |

A METHOD OF MOULDING AND A MOULDING  
FORMED BY SUCH A METHOD

- 5      The invention relates to a method of moulding and a moulding formed by such a method and is particularly, but not exclusively, concerned with a method of moulding a component for a motor vehicle.
- 10     Hitherto, it has been proposed to produce a vehicle body panel in a mould by initially injecting a plastics substrate material into the mould, subsequently opening the mould slightly, introducing into an injection moulding machine a low viscosity thermosetting liquid
- 15     paint having a viscosity of, for example, 8500 to 12500 centipoise at 25° C and injecting the liquid paint so that it flows between the injection moulded plastics substrate and the adjacent surface of the mould. As an alternative, it has also been proposed to inject such a
- 20     liquid paint between the previously injected plastics material and the adjacent mould surface without slightly opening the mould, such injection taking place before the injected plastics material has cured whereby the material can compress slightly as the paint is forced into the
- 25     mould. Injection of a coating material formed from liquid plastics supplied to an injection moulding machine to

provide a finish on a component is also disclosed in GB-A-2 039 246 and GB-A2 163 993.

Control of flow, pressure and cure of the paint during  
5 injection thereof are important to its surface finish and  
overall thickness integrity. Injection of liquid paint  
across the surface of the plastics substrate material is  
somewhat difficult to control and, therefore, it is  
difficult to obtain an even surface finish. Moreover, in  
10 the case of liquid paints which have a fast curing  
mechanism such that the moulding can be removed in a  
solid condition from the mould in a short time, the  
curing mechanism continually changes the rheology during  
injection, hence altering the controlling conditions.

15

In-mould coating of substrates using powdered plastics  
paint has also been proposed hitherto but involves the  
introduction of the paint in its powder form into the  
mould where it is heated to a melt temperature to form a  
20 film on the surface of the mould. The substrate is then  
placed in the mould so the paint becomes bonded to the  
surface of the substrate to form a finish. An example of  
such a method can be found in GB-A-1 420 867. Such a  
method is slow as it involves in-mould heating of the  
25 powder. Also, with a moulding the size of a typical  
vehicle body panel, eg a vehicle front wing, it would not  
be possible with such a method to obtain an even surface

finish and the panel would require subsequent painting outside the mould.

An object of the present invention is to provide an improved method of moulding and a moulding formed by such a method.

According to one aspect of the invention there is provided a method of moulding by injection comprising providing an injection moulding machine, introducing into the injection moulding machine a coating material in the form of plastics paint, providing a mould, providing in the mould a part to be coated with the paint and causing the injection moulding machine to inject the paint between the said part and an adjacent surface whereby the paint forms a coating on the surface of the part to provide a finish, characterised by utilising a paint formed by a powder paint manufacturing process, introducing the paint into the injection moulding machine and melting or softening the paint in the injection moulding machine so as to bring the paint into a form suitable for injection.

By injecting such a paint which has, when in an injectable form, a viscosity considerably higher than that of liquid paint, it has been found that the flow and viscosity profile of the material over the surface of the

said part is more easily controllable with the temperature and pressure of injection and a surprisingly good paint finish is obtained. The paint cure time can be controlled by controlling mould and/or injection temperature and, if desired, curing can be carried out outside the mould thus not affecting paint viscosity during injection. In fact, in accordance with the invention, it has been found possible with a suitable mould to obtain what is known as an automotive class A finish which is highly desirable as post-mould paint dipping or paint spraying of the component is not required.

The paint preferably includes a thermoplastic or thermosetting polymer, a colouring material, and an antioxidant. In such a case, the paint may also include one or more substances selected from finely divided metallic materials, finely divided pearlescent materials and UV stabilizers. Preferably, the paint includes at least one polymer compatible with the material from which the part is formed.

Where the said part is formed from a thermoplastic material, eg polypropylene, the paint may include a thermoplastic reversibly cross-linkable polymeric material, eg an ionomer.

A first application of the method may include producing

the said part in the mould by injecting into the mould a thermoplastic or thermosetting plastics material and injecting the paint after the plastics material has at least partially cured.

5

A second application of the method may include introducing into the mould a thermosetting plastics material of sheet-like form or dough-like consistency and pressing the material in the mould to form the said part. The mould may be made in at least two sections and the method may include pressing the said uncured thermosetting plastics material in the mould to form the said part by urging the two mould sections together, eg under a clamping load. The method may include using heat from the mould to assist curing of the thermosetting plastics material.

A third application of the method may include introducing into the mould sheets of thermoplastics mouldable material and pressing the sheets in the mould to form the said part. The mouldable thermoplastics material may comprise a glass mat filled polypropylene sheet (GMT). The method may include heating the sheets prior to introducing the sheets into the mould to soften the sheets and thereby bring them to a mouldable condition, and then allowing the sheets to solidify or cure at least partially prior to injecting the paint to coat the part.

The mould may be formed in at least two sections and the sheets of mouldable material are preferably pressed in the mould to form the part by urging the two mould sections together, eg under a clamping load.

5

A fourth application of the method may include providing the part in the mould as a metal part onto which the paint is injected. The metal part may be formed to shape in the mould prior to injecting the paint. The mould may  
10 be formed from at least two sections and the metal may be pressed in the mould to form the said part by urging the two mould sections together, eg under a clamping load.

The paint referred to herein before may be a polymeric  
15 paint with substantially thermosetting properties which will pass through a plastic phase as a result of applying heat thereto and the method involves injecting the paint between the said part and the adjacent surface while the paint is in such a plastic phase. The thermosetting  
20 plastics paint may either begin to cure as a result of heat applied thereto in the injection moulding machine or by heat applied thereto by the mould or at least said adjacent surface. Alternatively the coated part may be removed from its mould and heat may be applied at least  
25 to the paint coating thereon to complete the cure thereof.



The adjacent surface may be a surface of the said mould and in order to reduce the pressure required to inject the paint between the said part and the adjacent surface of the mould, the mould sections may be opened slightly prior to doing so. Opening of the mould may be facilitated by relieving a clamping load normally used to hold the two mould sections together.

According to another aspect of the invention, there is provided a moulding made by a method in accordance with the first said aspect of the invention or any of the consistory clauses related thereto.

Such a moulding may comprise a component of a vehicle, the paint preferably providing an automotive class A finish.

A method of moulding in accordance with the invention and a moulding made by such a method will now be described by way of example with reference to the accompanying drawings in which:-

Fig 1 is a diagrammatic cross-section through a two-section mould showing a plastics material injected therebetween to form a part to be coated with paint,

Fig 2 is a view of the mould shown in Fig 1 open slightly

so as to define a gap between a surface of the moulded part and an adjacent surface of the mould,

5 Fig 3 shows the mould of Figs 1 and 2 and a paint material injected between the said part and the adjacent surface of the mould,

10 Fig 4 is a cross-section through a mould similar to that shown in Figs 1 to 3 with its sections spaced apart and a thermosetting dough-like plastics material placed therebetween,

15 Fig 5 shows the mould of Fig 4 closed so as to cause the dough-like material to flow and fill the space between the mould sections.

20 Fig 6 shows the mould sections open slightly to define a gap between the moulded part and the adjacent mould surface,

Fig 7 shows the mould of Figs 4 to 6 with a paint material injected between the moulded part and the adjacent surface of the mould,

25 Fig 8 is a cross-section through a two-section mould showing heated sheets of thermoplastics material positioned therebetween,

Fig 9 shows the mould sections closed and the thermoplastics material filling the space between the mould sections.

5 Fig 10 shows the mould sections open slightly to define a gap between the moulded part and an adjacent surface of the mould,

10 Fig 11 shows the mould of Figs 8 to 10 with paint injected into the gap between the moulded part and the adjacent surface of the mould,

15 Fig 12 is a cross-section through a mould similar to that shown in Fig 3 with its sections spaced apart and a sheet of metal placed therebetween,

Fig 13 shows the mould sections closed with the sheet of metal pressed to shape by the mould,

20 Fig 14 shows the mould sections open slightly so as to define a gap between the metal part and an adjacent surface of the mould

25 Fig 15 shows the mould of Figs 12 to 14 and paint injected into the gap between the metal part and an adjacent surface of the mould,

Fig 16 is a cross section through a mould showing a part formed therein by the methods shown in Figures 1 to 3,

Fig 17 is a cross section of the lower mould section of  
5 Fig 16 and the part formed in Fig 16 positioned in an alternative upper mould section to define a space for receiving injected paint,

Fig 18 is a diagrammatic cross section through a mould  
10 which comprises a movable section defining two female mould surfaces for co-operation with a single lower mould section in order to produce a space for subsequent paint injection and

15 Fig 19 is a perspective view of a vehicle bonnet.

In Figs 1 to 3, the mould 10 comprises upper and lower sections 12, 13 as viewed in the drawings. The first section 12 defines a female mould surface 14 of  
20 complementary shape to a male mould surface 15 of the lower mould section 13. The lower mould section 13 is formed with an injection passage 16 through which plastics materials 17 is injected from a machine indicated generally at 18. The lower mould section 13 is  
25 also formed with a further passage 19 through which a paint material can be injected as described hereinafter.

With the mould sections 12, 13 in the position shown in Fig 1, a space 20 is defined between the two mould sections which receives plastics material 17 injected from the machine 18 as shown. The relative positioning of the mould sections 12, 13 may be controlled by suitable stops (not shown) and, during injection, the mould sections are held together by a clamping load L.

The plastics material 17 can either be a thermosetting material eg phenolic or epoxy resin or a thermoplastics material eg ABS or polypropylene. In the case of a thermosetting material, heat applied to the material in the machine 18 will be sufficient to cause the onset of curing of the material after injection into the space 20. Moreover, it is envisaged that at least the mould sections 12 will be heated to assist curing of the plastics 17 following injection. As an example, the material 17 may be Epoxy or Vinylester, and injected at a temperature of approximately 60-120° C. The mould 10 will be maintained at a temperature of around 120° C and curing of the material 17 takes place over a period of approximately 180 seconds.

Where the material 17 is a thermoplastics material, the mould 10 will be maintained at a temperature cooler than the injection temperature of the material 17 to aid the solidification or curing of a thermoplastics material. As

an example, the thermoplastics material 17 may be polypropylene and injected at a temperature of 200° C. The mould 10 may be maintained at a temperature of 80° C and solidification of the injected material 17 is likely to take around 60 seconds.

The cured material 17 forms a part 22 as shown in Fig 2. After curing, the mould sections 12, 13 are separated slightly to define a small gap 23 between the part 22 and the adjacent surface 14 of the mould section 12, the width of the gap 23 is indicated at W and may be approximately 0.15 mm. The dimension is shown exaggerated in the drawings.

An injection moulding machine 21 (Fig 3) has a barrel 21a to which paint 24 is fed from a hopper 21b. The paint 24 in the hopper 21b is in the form of chips, particles, granules, pellets, powder or other suitable form and is produced by a thermosetting/thermoplastic powder paint manufacturing process. In such a process, the paint components (such as those described below with respect to Figs 8 to 11) are mixed together and then extruded, for example, in the form of sheets or pellets. Where the paint is extruded in the form of sheets, the sheets may be broken or cryogenically ground into chips, powder or the like. If granules or pellets are required, the paint will normally be extruded in the form of thin rods which

are chopped into granules or pellets. Such manufacturing processes for the production of plastics powder paint are well known and will not be described further. The pellets, chips, powder or the like can be introduced into the hopper 21b directly for melting or softening in the injection moulding machine 21 to bring the paint into an injectable high viscosity condition.

Once the gap 23 has been defined, the melted or softened paint 24 is injected by the machine 21 through the passage 19 and between the part 22 and the adjacent surface 14 of the mould section 12 so as to fill the gap 23. The paint 24 thereby forms a coating 25 on the part 22 of depth W. The heated mould 10 assists flow of the paint 24 through the gap 23 and a surprisingly even paint finish is obtained. The surface 14 may be a chromium polished finish or the mould section 12 may be stainless steel having the surface 14 formed with a polished or other suitable finish to provide the required external finish on the coating 25.

Where the material 17 is a thermosetting material, the paint 24 is preferably a thermosetting material which, when heated, passes through a thermoplastic phase and injection of the paint 24 takes place while the paint is in its plastic condition. Heat applied to the material 24 in the machine 21 is sufficient to cause at least the

onset of curing of the injected paint material and at least the mould sections 12, 13 are maintained in the Fig 3 position for a time sufficient for the coating 25 to cure at least partially. Where the mould 10 is heated, heat from the mould will itself assist in curing the coating 25. After curing of the coating is completed, the mould halves are separated and the completed component indicated at 26 is removed from the mould.

10 In Figs 4 to 7, parts corresponding to parts shown in Figs 1 to 3 carry the same reference numerals.

In Fig 4, a piece of dough-like thermosetting plastics material 30 (such as Dough Moulding Compound (DMC) available from BIP Chemicals Limited, Popes Lane, Oldbury, England) is placed between the mould sections 12, 13 which are heated to a temperature sufficient to cause the onset of curing of the thermosetting plastics material eg 140° C. The quantity of the material 30 is such that when the mould is closed under load L as shown in Fig 5 the dough-like material 30 will substantially fill the space 20. The mould sections 12, 13 are left in the Fig 5 position so that the material 30 can substantially cure to form a part 32. The mould sections 12, 13 are then separated slightly as shown in Fig 6 to define a gap 23. A plastics paint 24 formed as described with respect to Figs 1 to 3 is then injected from the



machine 21 through the passage 19 so as to coat the part 32 and fill the gap 23 to form a coating 25. The paint 24 is a thermosetting material which, when heated, passes through a plastic phase and is injected through the passage 19 whilst in a plastic condition. Heat applied by the injection moulding machine 21 is sufficient to cause onset of curing of the paint 24 and the mould sections 12, 13 are left in the Fig 7 position for a sufficient length of time to enable further curing of the paint coating 25 to take place. The mould sections 12, 13 are then separated to enable the component indicated at 33 to be removed from the mould 10 and fully cured.

Typical curing time for the material 30 will be around 120 seconds with the mould 10 at 150-160° C and a typical curing time for the paint 24 with the mould 10 at that temperature will be around 120 seconds for onset of cure with postcure outside the mould of 600 seconds.

Instead of using a dough-like material 30, a thermosetting sheet moulding compound 35 known as SMC can be placed in the mould as shown in broken lines in Fig 4. The sheet 35 will spread so as to fill the space 20 when the mould sections 12, 13 are moved to the Fig 5 position. After the sheet has substantially cured, the steps shown in Figs 6 and 7 can follow.

With reference to Figs 8 to 11, parts corresponding to parts shown in Figs 1 to 3 carry the same reference numerals.

5 In Fig 8, sheets 40 of glass mat filled polypropylene (GMT) are heated to approximately 190° C and placed between the mould sections 12, 13. The mould sections 12, 13 will be cold or at least substantially cooler than the heated sheets 40 for example 100° C. The mould  
10 sections are then moved to the Fig 9 position under load L so as to cause the sheets 40 to flow outwardly and conform to the mould and substantially fill the space 20 between the mould sections. The temperature to which the sheets 40 are heated also causes the sheets to bond  
15 together homogeneously. Once the formed thermoplastic sheets have substantially cured to form a part 42, the mould sections 12, 13 are opened slightly so as to define a gap 23 between the part 42 and the adjacent mould surface 14. A thermoplastic paint 24 formed as described  
20 with respect to Figs 1 to 3 is then injected through the passage 19 so as to coat the part 42 and fill the gap 23.

A suitable thermoplastic paint 24 may be based on a mixture of thermoplastic material such as polypropylene  
25 and a concentrate of pigment to provide filling and/or coloration. In general moulding techniques, it is usual for such a material to be dispersed in a bulk polymer to

provide a material for moulding having desired qualities. Such a mixture is known in the art as Master Batch. A bulk polymer with the master batch dispersed therein will not exhibit the properties normally required of a paint, in particular the necessary depth of image and hardness/resistance to abrasion. To enable the thermoplastic material/pigment concentrate mixture to provide a paint coating in a method in accordance with the present invention, an additive is combined with the mixture to cause cross linking. A suitable additive is an acrylic-modified polyolefinic ionomer. An ionomer is a thermoplastic material provided with a low degree of cross linking in the solid state by the addition of a metal salt which provides ionic bonds between the polymer chains. By using the cross linking additive, a mould having a smooth surface will enable the paint coating to provide a surface finish having a depth of image and hardness which would not be exhibited by a moulded bulk polymer having the aforesaid mixture dispersed therein. Such a thermoplastic paint material suitable for coating a polypropylene substrate may comprise the following composition:

- 74.9% polypropylene
- 20% white pigmentation
- 0.9% antioxidant
- 0.2% UV stabilizer
- 4.0% acrylic-modified polyolefinic ionomer.

Such a paint will have an affinity for GMT.

Other suitable compositions for providing the paint coating are described in WO 94/06612 and WO94/06611 to which the reader is directed and the contents of which are incorporated herein by reference.

Once the paint coating 25 has solidified, the mould sections 12, 13 are then separated to enable the coated moulding indicated at 43 to be removed from the mould 10.

In Figs 12 to 15, parts corresponding to parts shown in Figs 1 to 3 carry the same reference numerals.

In Fig 12, a sheet of metal 50, eg mild steel, is placed between the mould sections 12, 13. The mould sections 12, 13 are then closed under the load L which presses the sheet 50 and causes it to conform to the shape of the mould surfaces 14, 15 to form a part 52. The mould sections 12, 13 are then separated slightly as shown in Fig 14 to define a gap 23 between the part 52 and the adjacent surface 14 of the mould 10. If desired, the metal sheet 50 can be pre-formed in alternative tooling to conform to the shape of the mould and then placed in position in the mould as in Fig 14.

Paint 24 formed as described with respect to Figs 1 to 3 is then injected through passage 19 so as to provide a

paint coating 25 on the part 52 and fill the gap 23 as shown in Fig 15. The injected paint 24 also flows around ends 52a of the metal part 52. Flowing around the ends in that way is a substantial improvement on stamped painted metal sheet which produces unpainted edges with no corrosion protection. As for the previous embodiments, the mould sections 12, 13 are left closed sufficiently long for the thermosetting paint 24 to cure at least partially and the mould 10 can then be opened to allow the coated moulding indicated at 53 to be removed.

Where the paint 24 is applied to a thermosetting material in the mould such as polyester, DMC, SMC or resin injection mould (RIM) epoxy, or to metal, a suitable thermosetting plastics paint is preferably used. Interpon UT1410 available from Courtaulds Coatings (Holdings) Limited of Felling Gateshead, Tyne and Wear is suitable for that purpose.

In Figs 1 to 7 where thermosetting materials 17, 30 and 35 are described and in Figs 12 to 15 where sheet metal 40 is used, a thermosetting paint 24 may be of a kind which can be finally cured outside the mould by applying heat thereto. Interpon 1410 is a suitable material for that purpose. The heat applied to the mouldings to cure the paint coating 25 in such a case will not have an adverse effect on the thermoset plastics underlayer or the sheet metal part. Also the finish provided by

coating 25 may be improved in that way as the applied heat can cause the paint to flow slightly providing a finish which is not entirely dictated by the quality of the mould surface 14..

5

The paint 24 will be of a kind such that the initially formed plastics part and the paint material 24 have an affinity for each other.

10

Where a plastics part is initially formed in the mould, cross-linking can occur between the plastics paint 24 and the plastics part where the plastics part is only partially cured when the paint 24 is injected by the machine 21.

15

An injection pressure of around 40 bar or higher may be required to inject the paint 24 through the gap 23 to coat the part in the mould where the mould 10 sections 12, 13 are separated to define the gap W. However, it is envisaged that instead of separating the mould halves 12, 13 to define a gap W, the clamping load L used to hold the mould sections 12, 13 together when injecting the paint 24 may be decreased to permit the paint 24 to be injected under high pressure between the part positioned in the mould 10 and the adjacent mould surface. The pressure of the incoming paint 24 can then cause the mould sections 12, 13 to move apart slightly against the

20  
25

reduced clamping load to permit the paint to coat the surface of the part.

It is also envisaged that the clamping load L can be maintained where the part initially produced in the mould is formed from a plastics material and the plastics material is not fully cured prior to the injection of the paint 24. In the latter case, the incoming paint 24 can cause a small amount of compression of the initially formed part to occur to enable the paint to coat the surface of the uncured plastic part.

Reference is now made to Figs 16 and 17 in which parts corresponding to parts shown in Figs 1 to 3 carry the same reference numeral.

Fig 16 shows a mould identical to that shown in Fig 1 where the part 22 is formed by injection. When the mould is opened as in Fig 2, the injected paint layer 23 will have a thickness W between the spaced apart horizontal surfaces of the mould sections 12, 13. However, the distance between the inclined flanks of the mould 22 (indicated at F1 in Fig 16) and the inclined opposite surface F2 of the mould section 12 will be spaced apart by a distance which is smaller than distance W so that the layer of paint covering the flanks will be thinner than that covering the horizontal surfaces of the part

## 22

22. Therefore, opening or causing the mould to open to enable the paint 24 to be injected will not produce an even coating of paint over shaped components.

5 In order to overcome that problem, the mould section 12 is replaced by a mould section 112 which has a female surface 114 shaped such that when the mould section 13 and the part 22 is placed against the mould section 112 as shown in Fig 17, the gap W is constant over the entire  
10 surface of the moulded part 22. In that way, the paint 24 is injected between the part 22 and the adjacent surface 14 and will form a coating 25 of even thickness over the part 22.

15 Fig 18 shows part of an automated moulding system comprising an upper mould section 212 having a female mould surface 14 similar to that of the mould section 12 in Fig 16 and a further female surface 114 similar to that shown in Fig 17. The mould section 13 co-operates  
20 with the surface 14 to produce the article 22. The mould section 13 is then lowered and the upper mould section 212 is shifted in the direction of arrow A so that the surface 114 aligns with the part 22. The mould section 13 is then raised into the position shown in Fig 18 so as  
25 to define a space 23 between the upper surface of the part 22 and the surface 114. The surface 114 is shaped to define a space 23 which is of constant thickness over



23

the whole of the upper surface of the part 22 and paint 24 is then injected to produce the coating 25. The mould section 13 is then lowered to enable the coated part to be removed.

5

The method described with respect to Figs 16 and 17 and Fig 18 can be used to produce articles as described with respect to Figs 4 to 15.

10

It is envisaged that the method in accordance with the invention can be used to form body panels of motor vehicles such as car bonnets, door panels, wings, sills and wheel trims, a bonnet 60 being shown in Fig 19. The bonnet 60 has a substrate 62 of plastic material initially formed in a mould in the same way as part 22 and an injected paint coating 25 preferably having an automotive Class A finish. A metallic finish for such components can be obtained by incorporating aluminium or mica particles flakes or platelets during the paint manufacturing process. Injection of a high viscosity fluid as obtained by the melted or softened paint 24 enables the flakes or platelets to be orientated in the correct plane.

15

20

25

30

The term powder paint used herein includes paint in the form of granules, pellets or the like. The powder paint manufacturing process referred to herein includes a manufacturing process which results in the production of powder or in the production of paint sheet, pellets, granules or the like from which powder can be formed.

## CLAIMS

1. A method of moulding by injection comprising providing an injection moulding machine (21), introducing into the injection moulding machine a coating material  
5 in the form of plastics paint (24), providing a mould (10), providing in the mould (10) a part (22;32;42;52) to be coated with the paint and causing the injection moulding machine (21) to inject the paint between the said part and an adjacent surface (14;114) whereby the  
10 paint (24) forms a coating on the surface of the part (22;32;42;52) to provide a finish, characterised by utilising a paint (24) formed by a powder paint manufacturing process, introducing the paint into the injection moulding machine (21) and melting or softening  
15 the paint in the injection moulding machine (21) so as to bring the paint into a form suitable for injection.
2. A method according to Claim 1 characterised in that the paint (24) includes a thermoplastic or thermosetting  
20 polymer, a colouring material, and an antioxidant.
3. A method according to Claim 2 characterised in that the paint (24) includes one or more substances selected from finely divided metallic materials, finely divided  
25 pearlescent materials and UV stabilizers.

25

4. A method according to Claim 1, 2 or 3 characterised in that the paint includes at least one polymer compatible with the material from which the part is formed.

5

5. A method according to any of claims 1 to 4 characterised by producing the said part (22) in the mould (10) by injecting into the mould a thermoplastics or thermosetting plastics material (17) and injecting the paint (24) after the plastics material (17) has at least partially solidified or cured.

6. A method according to Claim 5 characterised by introducing an uncured thermosetting plastics material (30;35) into the mould (10) in sheet-like form or in a dough-like consistency and pressing the uncured thermosetting plastics material (30;35) in the mould to form the said part (32).

7. A method according to Claim 6 characterised by providing the mould (10) in at least two sections (12,13) and compressing the said uncured thermosetting plastics material (30;35) in the mould to form the said part (32) by urging the two mould sections (12,13) together.

25

8. A method according to Claim 5, 6 or 7 characterised by using heat from the mould (10) to assist curing of the

thermosetting plastics material (17;30;35).

5 9. A method according to any of Claims 1 to 4 characterised by producing the said part (42) in the mould (10) by introducing into the mould a sheet of mouldable thermoplastics material (40) and pressing the sheet of mouldable thermoplastics material (40) in the mould to form the said part (42).

10 10. A method according to Claim 9 characterised by heating the sheet of thermoplastics material (40) prior to introducing the sheet into the mould (10) and allowing the sheet to solidify at least partially prior to injecting the paint (24) between the said part (42) and  
15 the adjacent surface (14;114).

11. A method according to Claim 9 or 10 characterised by providing the mould (10) in at least two sections (12,13) and pressing sheets of mouldable thermoplastics material  
20 (40) in the mould (10) to form the part (42) by urging the two mould sections (12,13) together.

12. A method according to any of Claims 1 to 3 characterised by providing the part in the mould as a  
25 metal part (50) onto which the paint (24) is injected.

13. A method according to Claim 12 characterised by

working metal (50) in the mould (10) to form the said part (52) prior to injecting the paint (24) between the metal part (52) and the adjacent surface (14;114).

- 5      14. A method according to Claim 13 characterised by providing the mould (10) in at least two sections (12,13) and pressing the metal (50) in the mould (10) to form said metal part (52) by urging the two parts (12,13) together.

10

- 15      15. A method according to any preceding claim including providing the paint (24) as a material which has thermoplastic properties but is thermosetting and will pass through a plastic phase as a result of applying heat thereto in the injection moulding machine and injecting the paint (24) between the said part (22;32;42;52) and the adjacent surface (14;114) while in such a plastic phase.

- 20      16. A method according to Claim 15 characterised in that the paint is Interpon UT1410.

- 25      17. A method according to Claim 15 or 16 characterised by using heat from the said surface (14;114) to assist curing of the paint (24).

18. A method according to Claim 15,16 or 17 including

applying heat at least to the paint coating (25) to cure the coating in a post mould curing step.

19. A method according to any preceding claim  
5 characterised by permitting or causing sections (12,13) of the mould (10) to open slightly prior to injecting the paint (24) between the said part (32;42;52) and a surface of the mould which defines said adjacent surface.

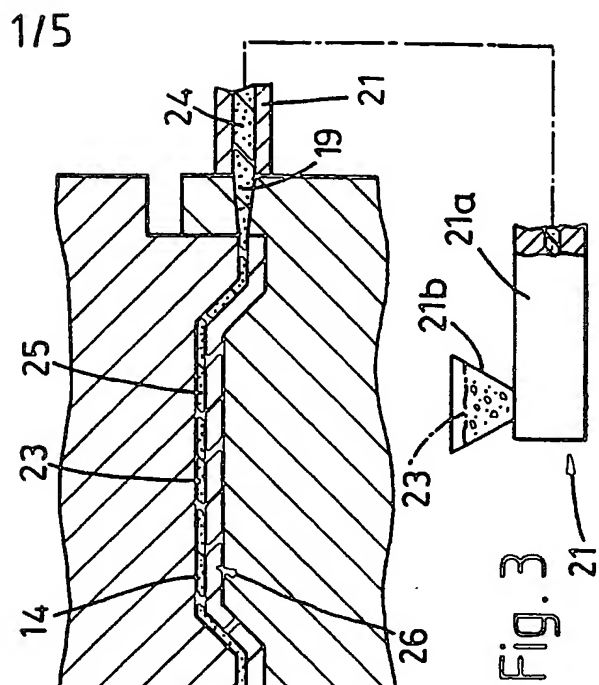
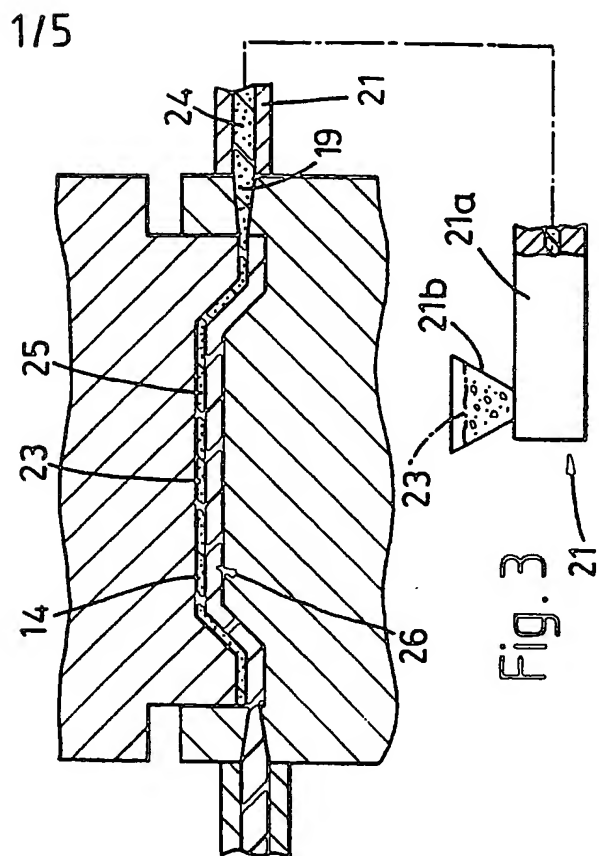
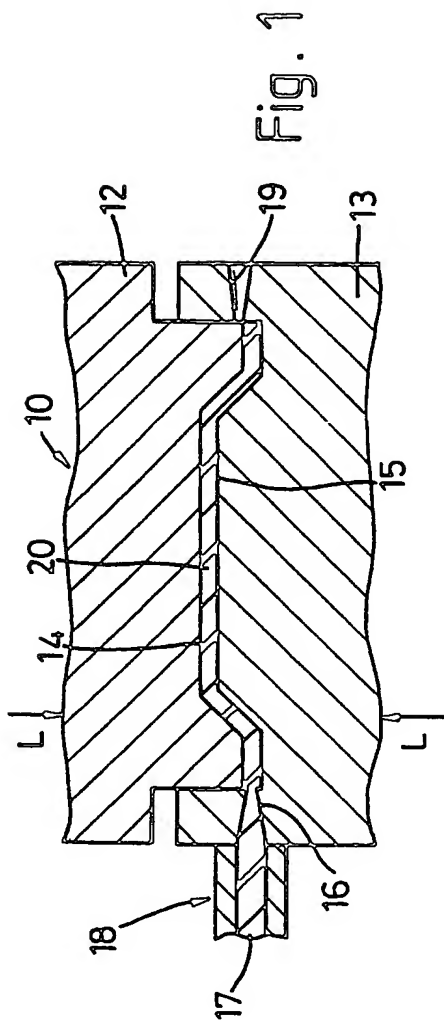
10 20. A method according to Claim 19 characterised by permitting the mould parts (12,13) to open by relieving a clamping load (L) normally holding the two mould sections (12,13) together.

15 21. A method according to any of Claims 1 to 14 or to Claim 19 or 20 when appendant to any one of Claims 1 to 14 characterised in that the said part (22) is formed from a thermoplastic material and the paint includes a thermoplastic reversibly cross-linkable polymeric  
20 material.

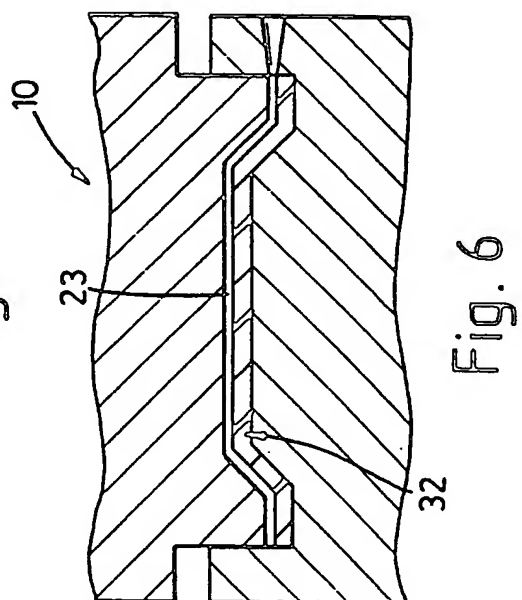
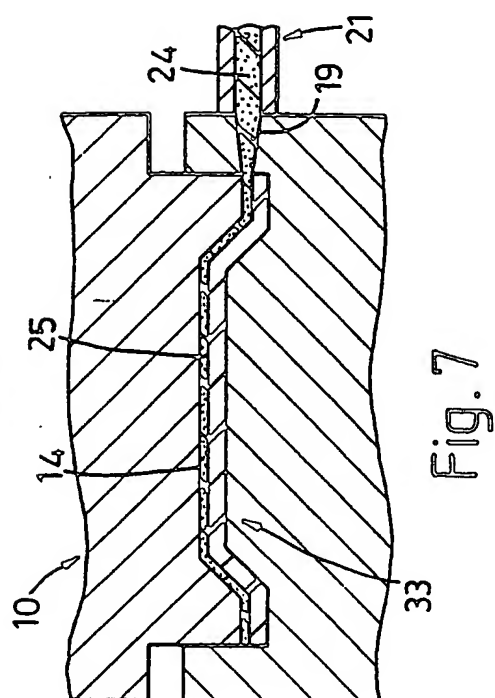
22. A method according to Claim 21 in which the reversibly cross-linkable material is an ionomer.

25 23. A moulding made by a method according to any preceding claim.

24. A moulding according to Claim 23 having an automotive Class A finish provided by the paint (24).
25. A moulding according to Claim 23 or 24 in the form  
5 of a painted motor vehicle component (60).







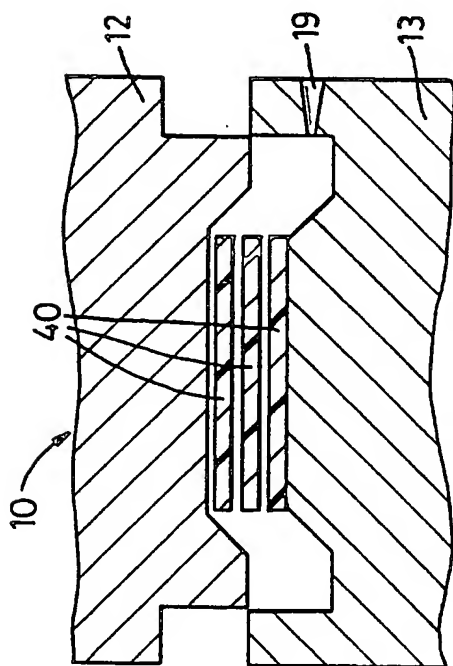


Fig. 8

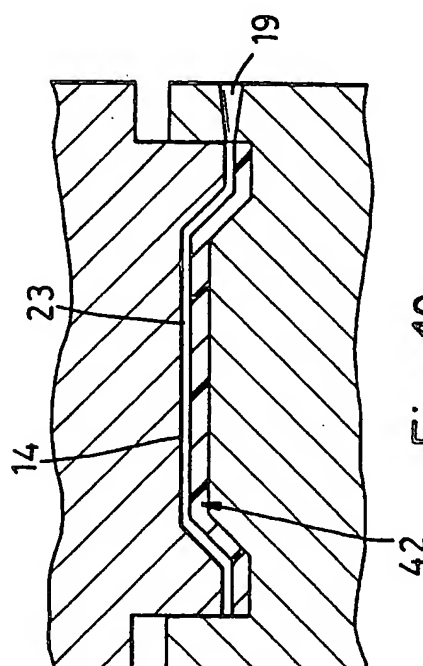


Fig. 10

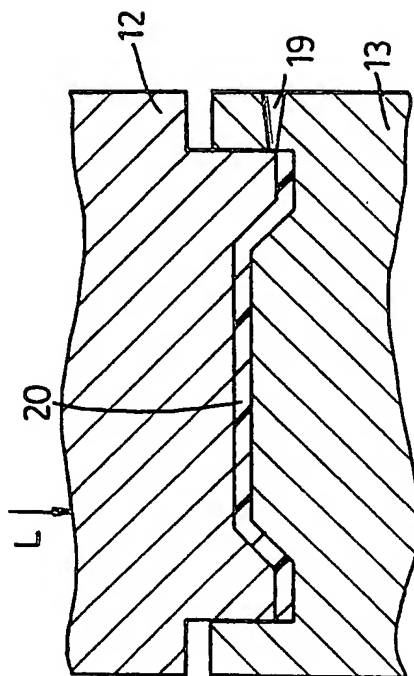


Fig. 9

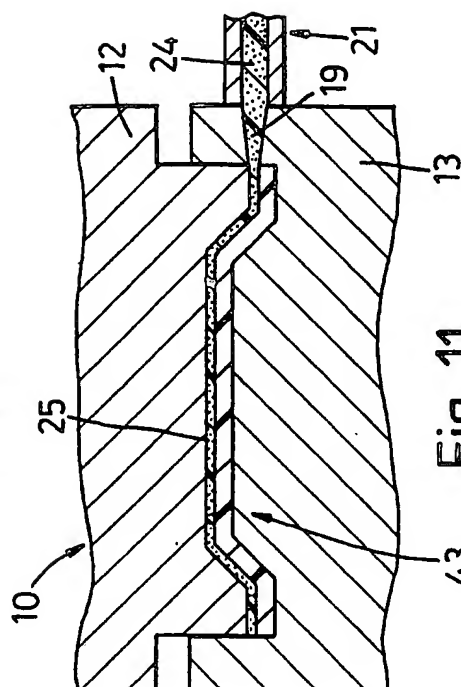


Fig. 11

3/5

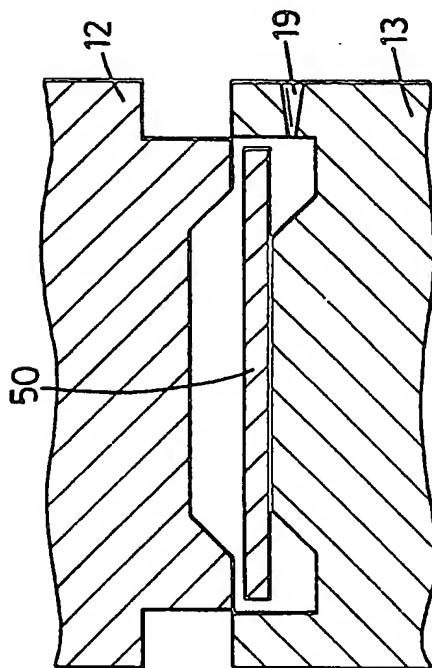


Fig. 12

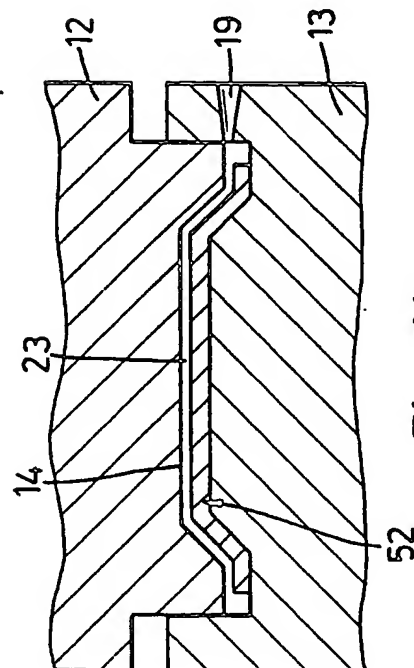
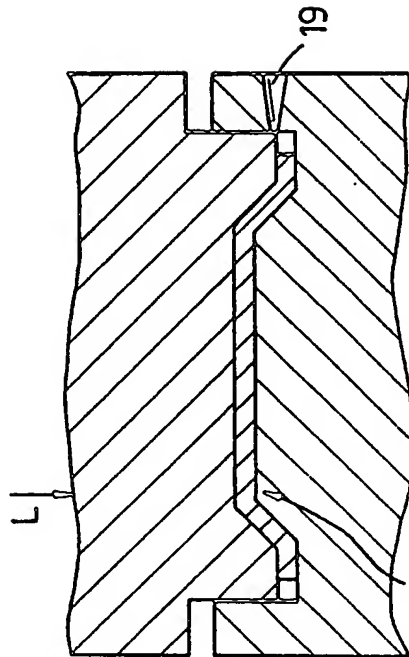


Fig. 14



4/5

Fig. 13

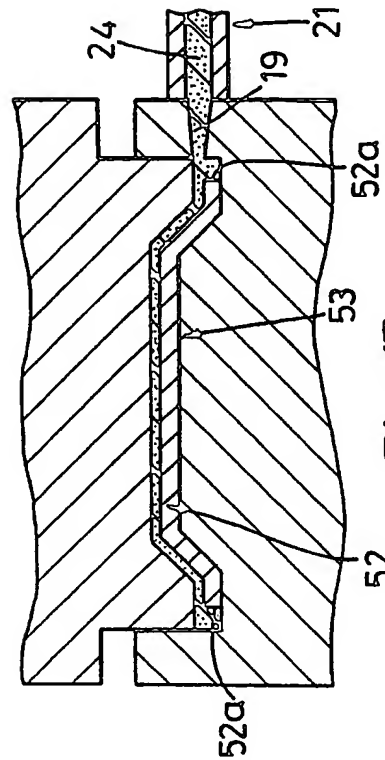
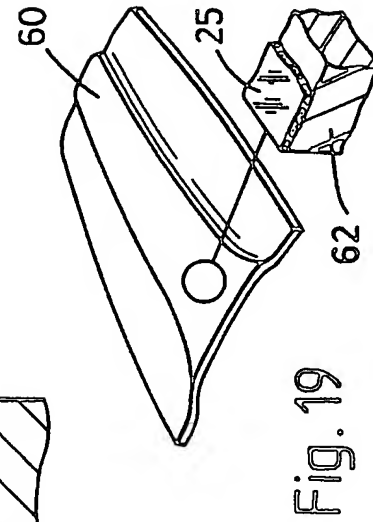
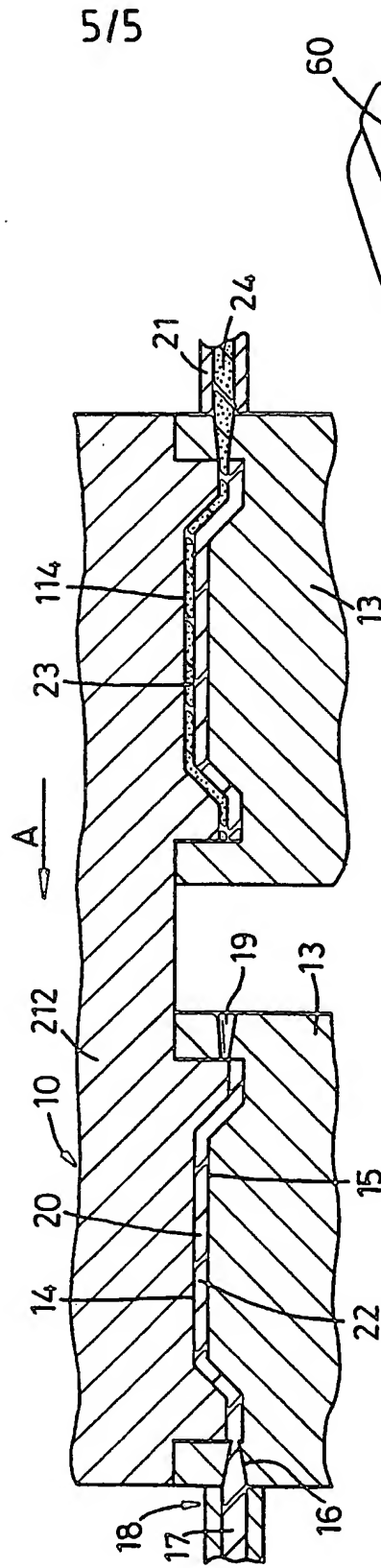
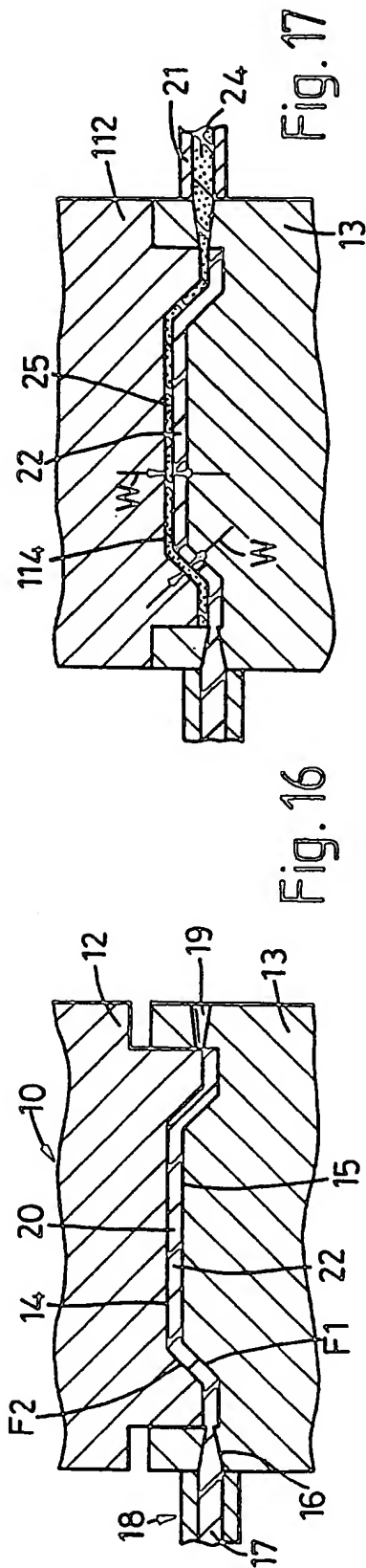


Fig. 15



# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/GB 94/02464

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 6 B29C37/00 B29C45/00 B29C45/16

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 6 B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages   | Relevant to claim No.          |
|-----------|--|--------------------------------|
| Y         | DE,A,24 61 925 (SOC. INT. PER LO<br>SFRUTTAMENTO DI BREVETTI) 20 November 1975<br><br>see the whole document<br>---  | 1,5,8,<br>15,<br>17-19,23      |
| Y         | PATENT ABSTRACTS OF JAPAN<br>vol. 12, no. 442 (M-766) (3289) 21<br>November 1988<br>& JP,A,63 173 616 (SUZUKI MOTOR CO) 18<br>July 1988<br>see abstract<br>--- | 1,5,19,<br>23                  |
| Y         | WO,A,93 17855 (ROVER GROUP) 16 September<br>1993<br><br>see claims 1,2,5,6,8,10,14; figures<br>---<br>-/--   | 1,3,4,8,<br>15,17,<br>18,21,23 |

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

### \* Special categories of cited documents:

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- \*Z\* document member of the same patent family

Date of the actual completion of the international search

27 February 1995

Date of mailing of the international search report

06.03.95

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Bollen, J

## INTERNATIONAL SEARCH REPORT

Inter national Application No  
PCT/GB 94/02464

| C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT |   |                       |
|--|---|-----------------------|
| Category   | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No. |
| Y  | AUTOMOTIVE ENGINEER,<br>vol.19, no.2, April/May 1993, BURY ST.<br>EDMUNDS GB<br>pages 28 - 29<br>'Vehicle and systems manufacturers are<br>increasingly making it with plastics'<br>--- | 1,23-25               |
| P,Y  | WO,A,94 06611 (H.B. FULLER CO.) 31 March<br>1994<br>see claims 1,6,12,13,17,19<br>---   | 1-3,<br>21-25         |
| P,Y  | WO,A,94 06612 (H.B. FULLER CO.) 31 March<br>1994<br>see claims 1,2,20,21,23,26,46-62<br>---   | 1-4,<br>21-25         |
| Y  | WO,A,93 06981 (ROVER GROUP) 15 April 1993<br><br>see claim 10; figures 1,2<br>---   | 6,7,9,<br>11,23       |
| Y  | PATENT ABSTRACTS OF JAPAN<br>vol. 10, no. 77 (M-464) (2134) 26 March<br>1986<br>& JP,A,60 219 035 (HONDA GIKEN KOGYO) 1<br>November 1985<br>see abstract<br>-----                       | 6,7,9,<br>11,23       |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 94/02464

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s)                                       | Publication<br>date                          |
|---|---------------------|--|--|
| DE-A-2461925                              | 20-11-75            | CH-A- 574321   | 15-04-76                                     |
| WO-A-9317855                              | 16-09-93            | EP-A- 0629150<br>GB-A- 2280401                                   | 21-12-94<br>01-02-95                         |
| WO-A-9406611                              | 31-03-94            | AU-B- 4828193<br>AU-B- 4828293<br>CN-A- 1085575<br>WO-A- 9406612 | 12-04-94<br>12-04-94<br>20-04-94<br>31-03-94 |
| WO-A-9406612                              | 31-03-94            | AU-B- 4828193<br>AU-B- 4828293<br>CN-A- 1085575<br>WO-A- 9406611 | 12-04-94<br>12-04-94<br>20-04-94<br>31-03-94 |
| WO-A-9306981                              | 15-04-93            | GB-A- 2274425  | 27-07-94                                     |